Winter vagility of the aquatic snail Lymnaea (Galba) bulimoides Lea

by

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INTRODUCTION

The pioneer work by Shaw & Simms (1929) showed that *Lymnaea (Galba) bulimoides* Lea is an intermediate host for the liver fluke *Fasciola hepatica* in Oregon. Nothing, however, is known about the ecology or behavior of this snail species. Studies on mollusc vagility in general have been few. Annual migratory cycles have been documented for *L. stagnalis appressa* Say by Cheatum (1934) and for *Fossaria parva* (Lea) by Hoff (1937). Moon (1940) investigated *L. peregra* Müll. and Van Someren (1946) discussed movement of *L. caillaudi* Bgt. in relation to dissolved oxygen. Bovbjerg (1952) showed that *Campeloma decisum* (Say) has a positive upstream movement and Pimentel et al. (1957) found that *Australorbis glabratus* (Say) maintained rather specific locations in a stream. The study reported here of the winter vagility of *L. bulimoides* in a body of water was undertaken to obtain information about its movement. This information may later be correlated with pasture sites of infection where livestock contract fascioliasis during winter and early spring.

MATERIALS AND METHODS

The experiment involved measuring the movement of the snail *L. bulimoides* by means of collecting, marking, releasing and again collecting marked snails, and noting the distances moved. A circular dip net measuring 25 cm diameter and 20 cm deep with a 76 cm hardwood handle was used for collecting snails by scraping the frame along the bottom of the drainage ditch. Soil, debris and snails were placed on a wire screen. The snails were brought to the laboratory immediately after capture, gently taken out of the soil with forceps and placed on a clean tray for several minutes. When their shells

were dry, paint with a water insoluble sulfon anide amidaldehyde resin containing less than 3% fluorescent dye dissolved in acetone (Daz-L, Maywood, New Jersey) was applied to the spire with a No. 2 camel hair brush. After the paint had dried, snails were returned to the site within six hours from capture time.

The study was done in a 91 x 0.61 x 0.61 m drainage ditch 8 km south-west of Corvallis, Oregon, at the south-east corner of section 18, range 5 west, township 12 south (U.S. Department of Interior Geological Survey Map, Corvallis, Oregon Quadrangle). The site was selected on the basis of the following characteristics: a width of 0.61 m, a water depth of 3-9 cm, shade and frequency of water plants. The length of the ditch was divided into three 30.5 m sections and marked with stakes. In each section, all snails that could easily be collected by three scrapings with the net were taken to the laboratory. They were then measured (spire apex to basal edge of the lip) with an optical micrometer set in the ocular of a 10-20 power stereomicroscope. They were marked with one of the two fluorescent paints designated for each of the outer 30.5 m sections and then released at either of the two center stakes (fig. 1).

Each released snail was gently placed on the soil in the ditch water at the points of release so that no snail remained floating. Of the 1000 snails, 500 were marked with orange paint and 500 were marked with green paint. The orange group was released at the center upstream stake and the green group at the center of the downstream stake. The two colors were used to detect differences in direction of snail movement at two locations.

To facilitate analysis of snail movements, each 30.5 m section was marked off into twenty-five 1.22 x 0.61 m areas. Each area was numbered as to so many meters upstream or downstream from the two center stakes (fig. 1).

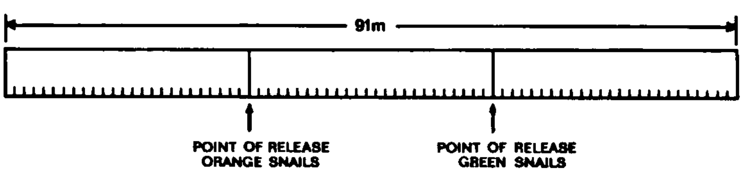

Fig. 1. Diagram of three 30.5 m sections each marked off in twenty-five 1.2 m segments with two centre points of release. H. Heijn del.

Observations of snails were made for ten weeks from December 26, 1968 to March 8, 1969. One check at noon each day for five

consecutive days was made during the first week and then one each week for the remaining nine weeks excluding the fifth, sixth and seventh when heavy snow and ice prevented driving to the site. Temperature readings were taken at each check time: water temperature was taken under water at substrate level and air temperature was taken 0.91 m above water level. Surface current was measured at each check time with a stop watch, meter stick and paper float. Substrate current was not measured. In order to survey the ditch site in a reasonable time period of three hours, only those snails which could easily be collected were examined. After examination, the snails were returned to approximately the same place of capture. Cursory examinations for snails were always made at least 61 m upstream and downstream from the outer marked sections.

RESULTS

Of the 1000 snails marked and released and the ratio of marked to unmarked snails collected after sufficient dispersal, it was calculated at the end of the tenth week that a total of 50,556 snails of between 4 mm and 11 mm long occurred in the study area. No correlation was made between vagility and snail size.

Time of observation	Distance (m) travelled downstream		Distance (m) travelled upstream		Number observed upstream	Number observed down-stream	Total number
	Estimated average	Range	Estimated average	Range			
Day 1	0.3	0.0-1.2	0.9	0.0-2.4	541	360	901
Day 2	0.6	0.3-1.2	0.9	0.3-2.4	548	340	888
Day 3	0.9	0.3-3.7	0.9	0.3-3.7	513	333	846
Day 4	0.9	0.3-3.7	1.2	0.3-6.1	440	327	767
Day 5	0.9	0.3-7.3	1.2	0.3-7.3	429	330	759
Week 2	1.2	0.3-11.0	1.5	0.3-9.8	417	341	758
Week 3	1.5	0.3-14.6	1.5	0.3-11.0	404	316	720
Week 7	1.5	0.3-13.4	1.5	0.3-15.9	394	317	711
Week 8	1.5	0.3-12.2	1.8	0.3-33.2	381	332	713
Week 9	1.5	0.3-9.8	2.1	0.3-33.2	342	327	669
Week 10	1.8	0.3-9.8	3.4	0.3-33.5	326	249	575

Table 1. The movement of *Lymnaea bulimoides* from points of release in a drainage ditch.

Over half the marked snails found a migratory direction against the stream current within the first 24 hours (figs. 2, 3). Movement upstream by snails against a current speed of 0.072 cm/sec (± 0.01) for ten weeks continued to be greater than movement downstream by a factor of 0.33. An average of 10% more snails were recovered upstream than downstream during the study. The estimated average distance traveled upstream was nearly twice as large as the distance downstream. The average range of movement upstream was 17 m or over half the range of 7 m for downstream movement (table 1). There was no difference in direction of snail movement from the two release points.

Unmarked snails were fairly well distributed in the study area (figs. 2, 3). Seldom were there collected more than 100 unmarked snails in any one 2.4 m^2 area. Fluctuations in numbers of unmarked snails 1.2 m of both upstream and downstream release points were detected after releasing the marked snails. This continued throughout the ten weeks.

Tenth week collecting yielded nearly identical numbers of unmarked snails as compared to the first 24 hours.

Temperatures which could be measured during the ten week study period averaged below 4.8°C. The average falls below this figure because of a three week interval of bad weather when readings could not be made at the site. Average water temperature was slightly below 6.6°C for the same reason. It may safely be said that at no time during the harsh winter season did the water temperature at the bottom of the stream drop below 1°C (fig. 4).

DISCUSSION

In many aspects concerning life cycle and ecology *L. bulimoides* is quite similar to the aquatic snail *Aplexa hypnorum* (L.) found in the Molenpolder at Yerseke, Holland (Den Hartog & De Wolf, 1962). Both are found in shallow ditches on soil of about the same type. Both are extremely tolerant of cold and desiccation. Both have life spans coinciding with the time between the end of the summer drought in one year and the beginning of the drought in the next year.

L. bulimoides tolerance to cold is indicated by its ability to survive in the laboratory at a water temperature of 5°C for more than three months with or even without food. Movement is slowed

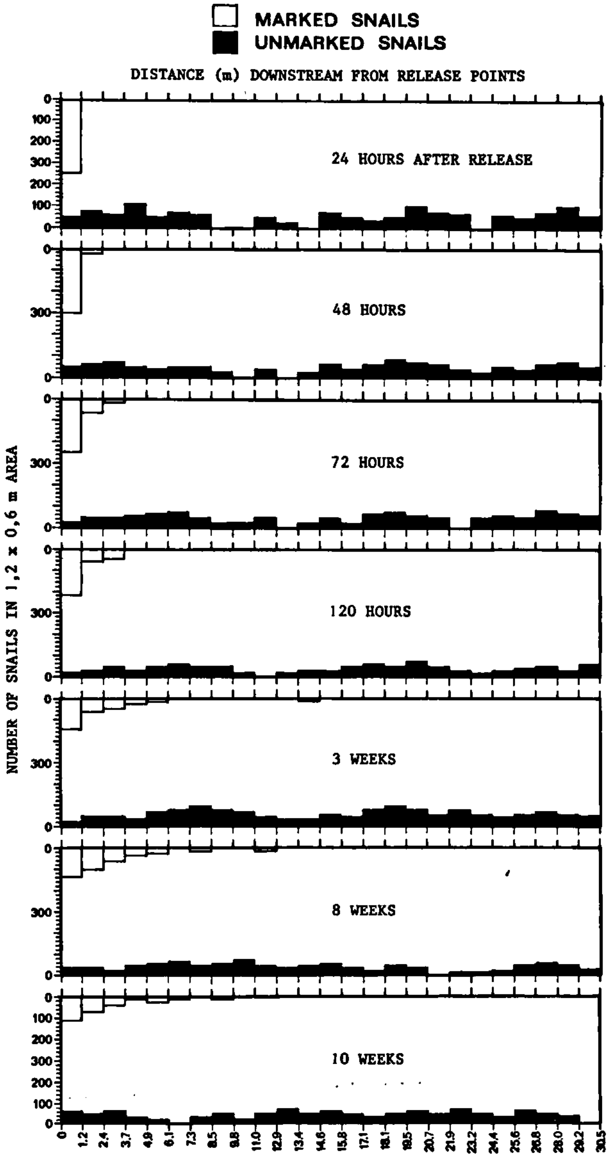

Fig. 2. Downstream movement and distribution of marked snails and distribution of unmarked snails in two 30.5 m sections from points of release. H. Heijn del.

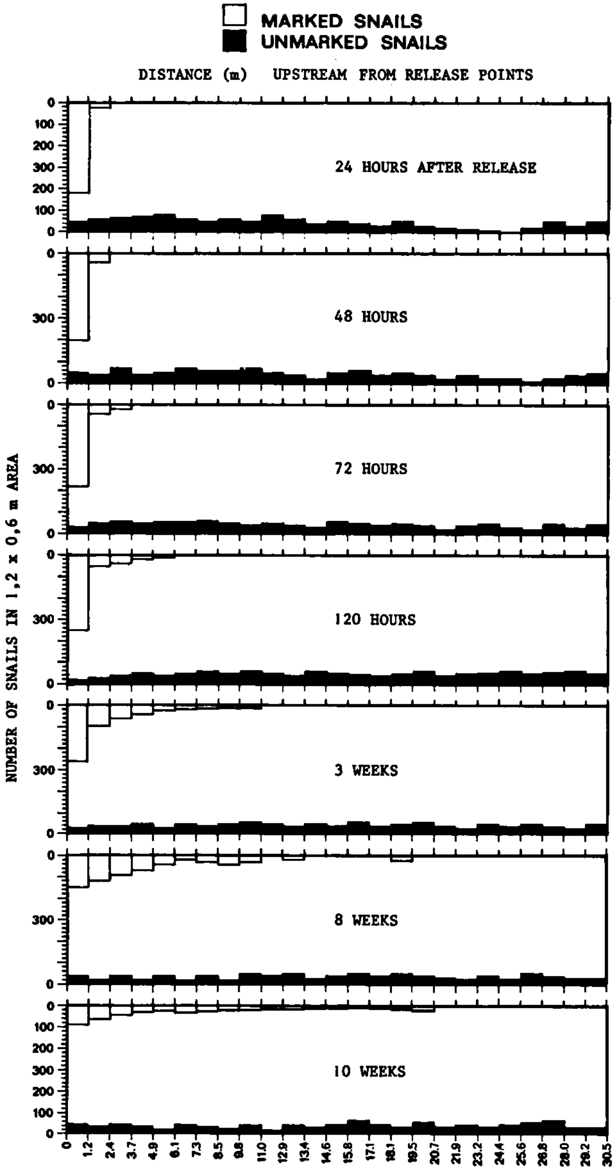

Fig. 3. Upstream movement and distribution of marked snails and distribution of unmarked snails in two 30.5 m sections from points of release. H. Heijn del.

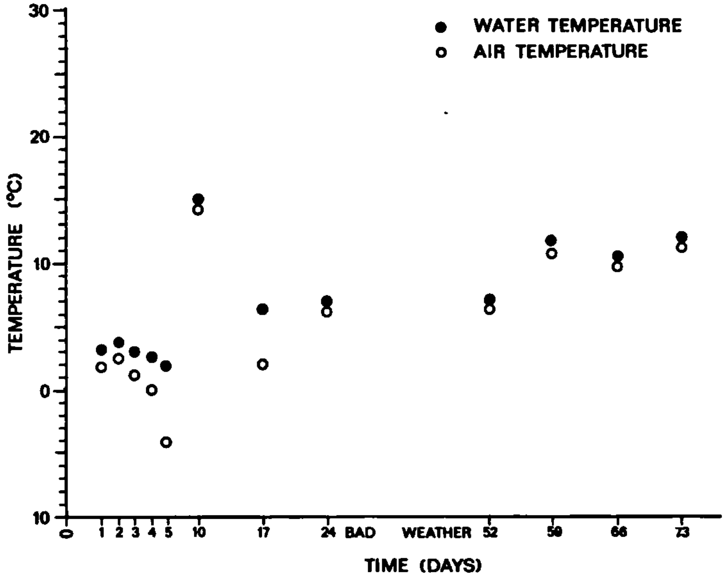

Fig. 4. Mid-day temperatures of air and water at the study site for a ten week period. Days nos. 1-73 are 26-30.XII.1968 inclusive, 4.I, 11.I, 18.I, 15.II, 22.II, 1.III, and 8.III.1969. H. Heijn del.

considerably at this temperature. Low temperature may account for the slow dispersal observed in this field study. The low winter temperatures in the field undoubtedly retarded normal physiological functions sufficiently to slow movement but obviously did not inhibit reproduction, feeding or complete hibernation.

The experiment was done during the worst winter the area had in twenty-five years. During the ten weeks heavy snow, ice, rain and wind played on the site. Rarely was there sunny weather. How snail movement would compare during opposite weather conditions remains to be demonstrated. From the fact that viable egg masses as tested were found every week and from the fact that water temperatures on the stream bottom were always above that of the air, it may be that the snails were little affected by conditions above. Water movement probably aided in smoothing out the temperature. According to Hubendick (1958) freshwater snails as a rule are decidedly euryoke and have the wide ecological tolerance necessary for survival. This is supported by Segal (1961) who discussed acclimation among molluscs.

Slow dispersal at the release points may also have been due to handling, marking, crowding or an abundance of food. Every effort was made to minimize these effects. Handling and marking were done with great care. Snails were evenly dispersed by hand at the release points in a segment of the ditch selected for uniformity in vegetation.

It appears that *L. bulimoides* demonstrates a rheotaxis. This has also been noted for *Campeloma decisum* and according to Fraenkel & Gunn (1940) it appears to occur in practically all active inhabitants of streams. Moving against the current can be considered a positive response. Whether or not such a response occurs on an inclined substratum remains to be discovered. Gradients of gravity as well as current may be linked. Movement of water in the habitat effects both aeration and mechanical friction and inhibits the accumulation of sediment and growth of water vegetation. To what extent these act as limiting factors on *L. bulimoides* is unknown.

Movement of *L. bulimoides* to specific habitats or to original positions before collection and start of the study did not occur. At the end of the tenth week many areas were devoid of marked snails. Before the experiment, these areas contained snails that were eventually collected and marked. It should be mentioned, however, that each weekly collection yielded diminishing returns. Fewer snails were collected in all but four of the twenty-two collecting periods. The decrease in marked snails may be due to predators. Birds could easily have spotted the bright orange or green colored snails in the small body of water. Snails were frequently found under a layer of silt at the stream bottom amid the dense bent-grass *Agrostis palustris*, high on the banks of the stream or dead in the stream. Since net sampling could not cover all areas, visual counting had occasionally to be relied upon. In either net sampling or visual observation, snails found dead were discarded away from the study area. No formal mortality counts were made, but a death rate of over 10% is not unlikely. Another reason for the decrease in number of marked snails was the disappearance of the paint mark. This was not, however, frequently seen. A final reason for the decrease in number and for the termination of the study was the heavy growth of algae of the genera *Vaucheria, Tribonema* and *Zygnema* at the start of spring. After the tenth week it became impossible to find snails as many were hidden in between the algae.

The abundance of vegetation in the stream influenced by the silty clay loam substratum probably acted as a temporary barrier to more

distant movements as well as providing protection against the influences of the weather. Chemoreception by the snails of nearby vegetation or distant food may also have influenced movement. This, as well as the role of escape responses from predators in determining distribution patterns, has yet to be determined. The tendency to move up on dry land was infrequently seen. Snails tended to stay in the water.

L. bulimoides apparently is capable of moving great distances by means other than via soil substratum. Although floating on the surface of the water in an inverted position was observed only once, it took place within a 72 hour span and the distance traveled was 30.5 m. How many snails escaped observation by floating away remains unknown. This ability alone would allow rapid repopulation of an area.

Although other studies, as yet unpublished, have shown *L. bulimoides* to occur in ditch soil during winter, the majority of them are active on top of the soil, in the water or on the water surface. The fact that the snail is active and moving may possibly be correlated with the release of metacercariae from infected snails along lengths of ditches and the subsequent contraction of fascioliasis by domestic livestock that frequent these areas during the winter months.

ABSTRACT

One thousand *Lymnaea bulimoides* were marked and released at two points in a 91 x 0.61 x 0.61 m drainage ditch eight kilometers south-west of Corvallis, Oregon, in December, 1968. They were observed from December, 1968 to March, 1969. A rheotaxis to movement against water flow was observed. During the first 24 hours an average distance of 0.91 m was recorded for snails moving upstream and 0.31 m for those moving downstream. Between the third and seventh week, an average distance of 1.52 m both upstream and downstream was recorded. By the tenth week, *L. bulimoides* had moved an average distance of 3.35 m upstream and 1.83 m downstream. Possible reasons for these movements are discussed.

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